Space Weather Technical Forecast

Issued on Saturday, 09 September 2023 at 13:15 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Chance of M-flares (R1-R2 radio blackouts). Slight chance of CME arriving late on Day 1 (09 Sept) or early Day 2 (10 Sept).

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Low over the past 24 hours, with a peak flare of C8.4 at 09/0120 UTC, originating from AR3421 in the northwest. There are currently five numbered and two unnumbered sunspot regions on the visible disc. The largest region is AR3423, with continued slight growth observed. The elongated AR3421 (Eao/Beta) also continues to see some slight development, though changes in classification becoming harder to observes as it rotates towards the western limb. AR3424 (Bxo/Beta) is small and fairly simple, as is the recently re-added AR3418 (Bxi/Beta) to the north of AR3421. AR3425 has shown some consolidation of its leader spot, with its intermediate spots fading and a slight reduction in its magnetic complexity. Two new unnumbered Axx spots developed in the southern hemisphere. No Earth-directed CMEs have been observed in available coronagraph imagery in the past 24 hours.

Solar Wind / Geomagnetic Activity: Solar wind parameters, as measured at L1, were indicative of a slow regime. Solar wind speeds were mostly around 350-400km/s. Density was average to below average throughout. The IMF was weak and below 7nT throughout. The north-south component varied weakly between +/-6nT. The phi angle was mostly negative (towards the Sun). Geomagnetic activity was Quiet to Unsettled (Kp 0-3).

Energetic Particles / Solar Radiation: GOES16 high energy (greater than 10MeV) proton flux has been at background levels throughout. GOES16 high energy (greater than 2MeV) electron flux was predominantly at background levels but became moderate for a time, peaking at 835 pfu at 08/1645 UTC. The associated 24-hour fluence was below the Active threshold on a declining trend, with 2.43e7 integrated pfu observed at 09/0000UTC.

Four-Day Space Weather Forecast Summary

Solar Activity: Solar activity is expected to remain mostly Low but with an ongoing chance of isolated M-class flares, mostly from AR3421 and AR3423, and a very slight chance of an isolated X-class flare.

Solar Wind / Geomagnetic Activity: A slow CME which left the Sun on 05 Sept has been modelled to have Earth-directed component, expected to arrive late on Day 1 (09 Sep) or early Day 2 (10 Sep), with a increase in wind speeds to 400-450km/s possible, bringing a chance for some enhancement of geomagnetic activity. No other Earth-directed CMEs have been observed in the last 24 hours. In the absence of significant CME effects, the solar wind is most likely to remain slow-ambient, though there may be slight enhancements at times. Geomagnetic activity is expected to be mostly Quiet to Unsettled, but with a risk of becoming Active with a slight chance of isolated G1/Minor Storm intervals late on Day 1 into Day 2 (09-10 Sep) should we see any CME influence. Mostly Quiet to Unsettled conditions expected to return Days 3 and 4 (11-12 Sept).

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Energetic Particles / Solar Radiation: High energy (greater than 10 MeV) proton flux is expected to remain at background levels, with a very slight chance of an enhancement should any larger flares occur.

High energy (greater than 2 MeV) electron flux carries some uncertainty, however it is thought most likely that fluence will remain below the Active (1e8 integrated pfu) threshold throughout, with just a slight chance of reaching this level later in the period.

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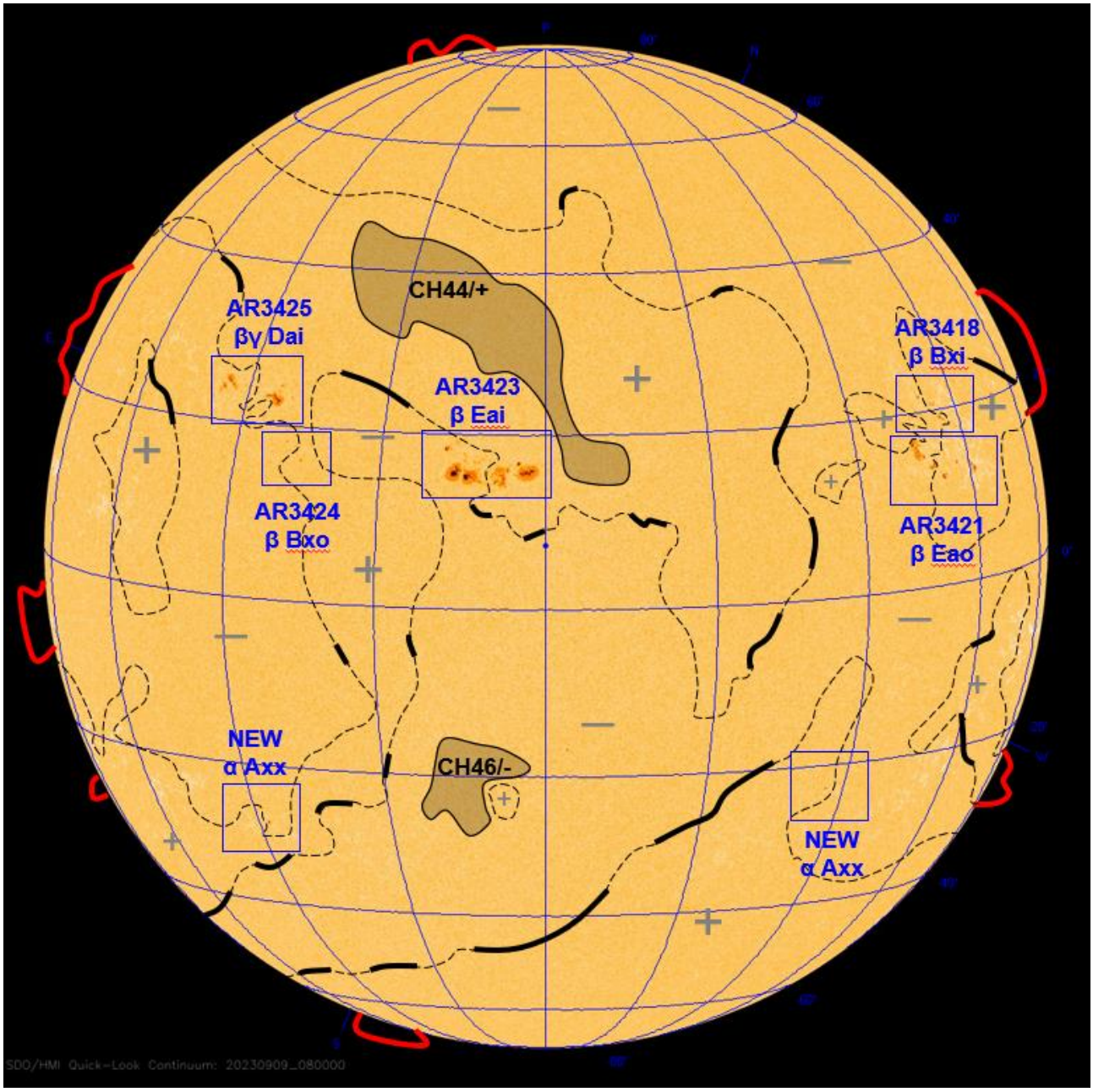
Figure 1. Solar Analysis Valid 09/0800 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

A slow CME which left the Sun on 05 Sept has been modelled to have Earth-directed component, expected to arrive late on Day 1 (09 Sep) or early Day 2 (10 Sep), with a increase in wind speeds to 400-450km/s possible bringing a chance for some enhancement of geomagnetic activity. However, analysis of this CME was contaminated by far side activity, thus reducing confidence significantly. No other Earth-directed CMEs have been observed in the last 24 hours. There are a significant number of filaments on the visible disc however, and these will need to be closely monitored for any lift-off.

With an absence of significant CME effects, the solar wind is most likely to remain slow-ambient, though there may be slight enhancements associated negative coronal holes no longer visible on SDO imagery. The solar wind persistence model (SWPM) is considered to give good guidance in that respect.

Geomagnetic activity is expected to be mostly Quiet to Unsettled, but with a risk of becoming Active with a slight chance of isolated G1/Minor Storm intervals late on Day 1 into Day 2 (09-10 Sep) should we see any CME influence. Mostly Quiet to Unsettled conditions expected to return Days 3 and 4 (11-12 Sept).

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	10	10	5	1
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
06/0610	Partial	Plage	S-Centre disc	440km/s	09/2100 UTC +- 9hr	Limited impact expected.

Figure 2: Latest MOSWOC ENLIL Ensemble model output, showing potential CME impact. Note more general increase in wind speeds from the 12th, likely associated with large coronal hole area CH44/+. This viewed as somewhat too early hence no currently included in four day forecast.

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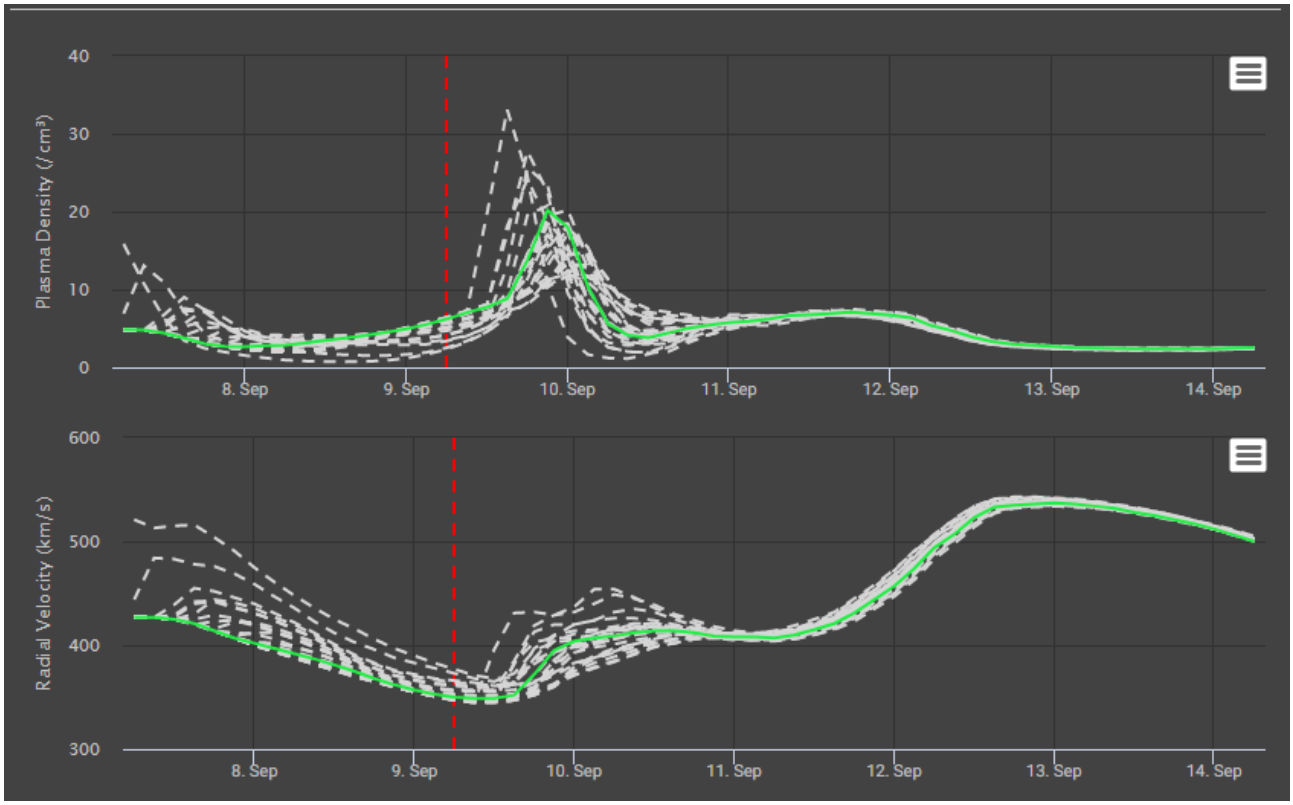

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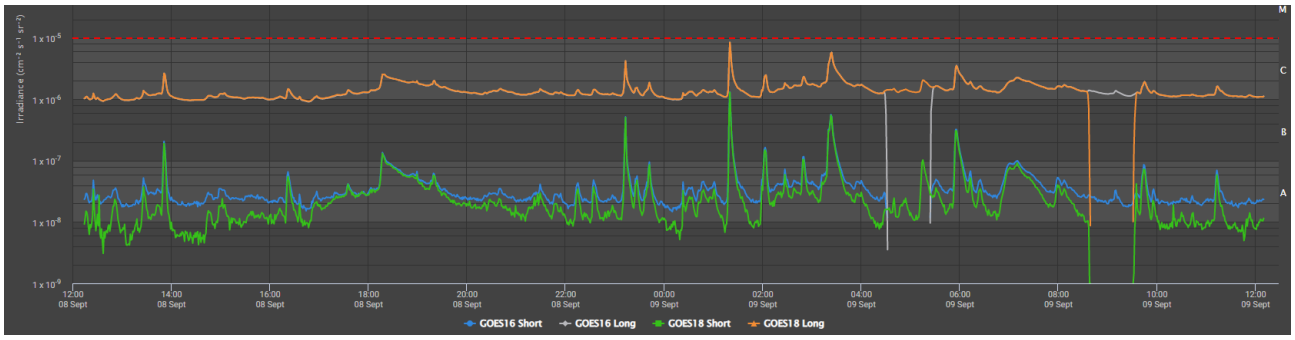
Radio Blackouts - X-Ray Flares:
There are currently five numbered and two unnumbered sunspot regions on the visible disc. The largest regions is AR3423 and AR3421 continue to see slight development but have become magnetically simpler. These regions currently providing he bulk of the flare risk. The developing AR3418 to the immediate north of AR3421 will need monitoring given signs of low level flaring. AR3425 also remains magnetically complex, though some signs of consolidation.

The AR3418/AR3421 area is expected to depart the disc by the end of the period bringing a slight reduction in flare probability. However, there are signs from far-side soundings that one or more new regions may rotate onto the disc in the coming days. Therefore the current flare risk is maintained through the period. Solar activity is expected to remain mostly Low but with an ongoing chance of isolated M-class flares, mostly from AR3421 and AR3423, and a very slight chance of an isolated X-class flare.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	No	40	40	40	40
Very Active	R3 to R5 X Class	No	5	5	5	5

Figure 3: Latest 24hr X-Ray Flux



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Solar Radiation Storms - (High Energy Protons):
The high energy (greater than 10MeV) proton flux observed by GOES16 is now at background levels.

Proton flux is most likely to remain at background levels, although there is a very slight chance of enhancements over the next few days, should any significant flares occur.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	5	5	5	5
Very Active	**≥ S3 ***	No	1	1	1	1

* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)

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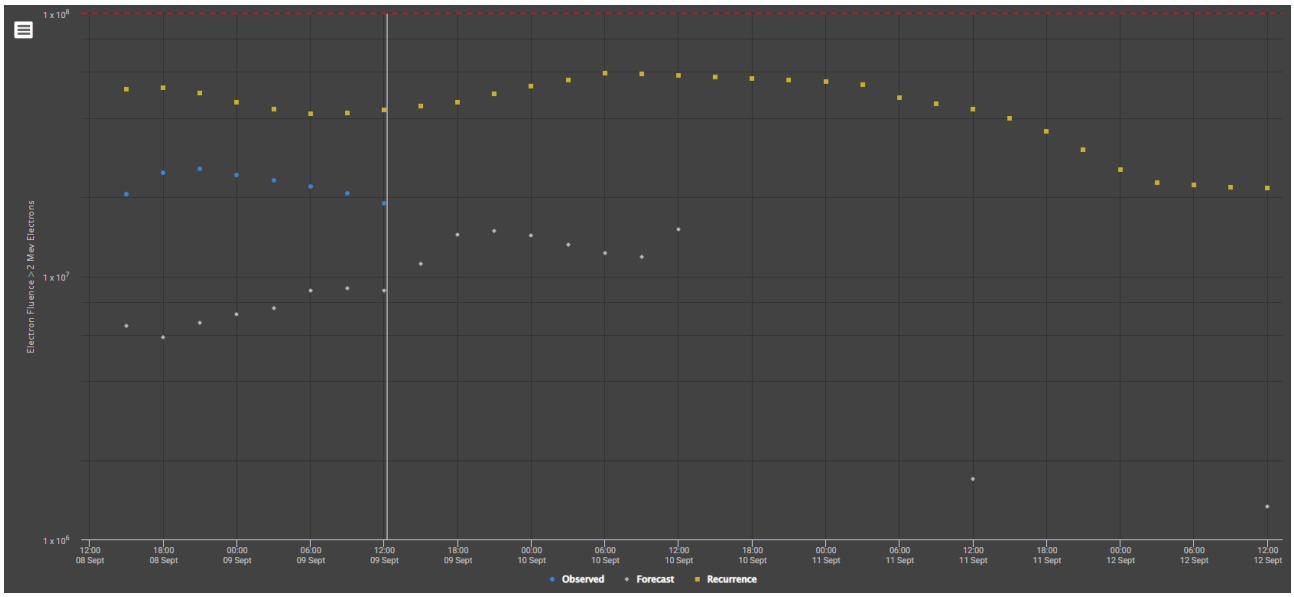
High Energy Electrons Event (≥ 2MeV):
High energy (greater than 2 MeV) electron flux is likely to remain at background to moderate levels for much of this period, with significant enhancements to the electron belt looking unlikely. An increase in flux and fluence levels is possible towards the end of the period. However, there is also the potential for a CME arrival late on Day 1 (09 Sep) into Day 2 (10 Sep) which may suppress electron levels once again.

The associated 24-hour fluence will most likely remain below the Active (1e8 integrated pfu) threshold throughout the period, but with decreasing confidence with time. MOSWOC REFM is considered to be giving good guidance initially, however, confidence falls through the period given the possible arrival of a weak CME.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	5	10	15	20
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

Figure 4: Latest MOSWOC REFM model output



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